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SATURDAY, DECEMBER 10, 1881.

SIR—On the evening of November 24, I noticed that the spectrum of the star DM. +36° 3987 has a bright band in the blue. The star, accordingly, belongs to the small class of objects which comprises Rayet's stars in Cygnus (near this one) and Oeltzen 17681, discovered here in 1880.

On November 25 I found a small planetary nebula, undistinguishable from a very faint star by the ordinary eye-piece, bnt detected by the character of its spectrum. Its place for 1880 is in R.A. $20^h\ 6^m\ 26^s.4$, declination $+37°\ 3'\ 25''$. It follows W. xx 200 eight seconds, three minutes of arc farther south, and is followed respectively $2^s.6$ and $2^s.3$ by two faint stars north 37″ and south 20″ of the nebula.

HARVARD COLLEGE OBSERVATORY,
CAMBRIDGE, *December* 1, 1881.

EDWARD C. PICKERING.

SHALER AND DAVIS' "GLACIERS."[1]

BY W. J. MCGEE.

I. Introduction.—The extensive superficial modification of the globe accomplished through the agency of water in its three states of aggregation has been rendered possible by certain properties peculiar to this substance, chiefly (1) its powers of assuming the several forms of solid, liquid, and vapor within the narrow range of terrestrial temperature, (2) its enormous capacity for heat, and (3) its power of dissolving other substances.

The temperature of the earth's surface is indeed largely determined by the aqueous vapor contained in the atmosphere; for if it were not for this vapor the solar energy falling upon the earth would be radiated away almost as quickly as received, and could exercise but little influence upon temperature. The narrow range of terrestrial temperature since the beginning of the organic record attests the enormous capacity and marvelous delicacy of this temperature—equalizing agent, for within the limited bounds of the space separating earth and sun, the temperature varies from a hundred thousand degrees above to two hundred and fifty degrees below the Fahrenheit zero; though accidents in this adjustment are attested by the traces of successive ice periods in the geological history of the globe. The influence of liquid water in producing the various phases assumed by the earth's surface, during geological time has long been the subject of study; but it is only within the last forty years that the newly commensurate influence of ice has been detected.

II. *The existing glaciers of the earth.*—The most accessible of the existing glaciers are those of the Swiss Alps; and the best route for the student to pursue in entering this region is to pass up the valley of the Rhone.

Here, aside from the more obscure evidence of the former great extension of the glaciers, the various works of ice-action became constantly fresher in ascending the river until they disappear beneath the wall of ice constituting the terminal portion of the glacier. At the foot of this ice wall is an irregular mass of stones and earth—the *terminal moraine*—lying across the valley, cut in twain by the muddy stream emerging from a cavern in the basal portion of the glacier; and the ice itself is gullied by tiny rills and soiled with sand and dirt, and hardened with pebbles and rock fragments, which from time to time roll down its steep front, to the morainal heap below. When the glacier shrinks for several successive seasons, as occurs when the weather is unusually dry and warm, the stream flowing from it becomes a torrent, and the moraine may be separated from the ice front by a belt of striated and polished rock, but sparsely covered with coarse *debris*; but when the ice advances for a number of years the stream dwindles, and the sheet of earth and stones is pushed forward and crumpled up into a mighty embankment, rising into a range of irregular hillocks. Many such ridges attest the various periods of temporary advance in the history of most of the secularly retreating glaciers. On ascending the ice stream itself, the superficial rock-fragments, pebbles, and earth are found to lie mainly in parallel bands, or *medial moraines*; and on tracing these to their origin, each is seen to consist of the two lines of matter constantly tumbling down the valley sides or *lateral moraines* which are brought into contact whenever two glaciers meet and merge into one. Thus the number of branches uniting to form any glacier can be determined from the number of parallel bands on its surface. The ice-stream occupies a crooked and irregular valley, the rate of its motion varying with the declivity, regularity, and width of the channel, just as does that of liquid rivers; though wherever there are considerable irregularities in the channel the strain produces cracks and fissures which gradually widen and form *crevasses*, or even, where there is a sudden increase in declivity, separates the ice into a mass of irregular pyramidal blocks, or *seracs*; but when a more uniform stretch of gentle slope is reached the seracs re-unite, and the crevasses close, transforming the fragmentary mass again into a solid,

[1] "Illustrations of the earth's surface. Glaciers; by Nathaniel Southgate Shaler, professor of Paliontology, and William Morris Davis, instructor in Geology, in Harvard University, Boston. James R. Osgood & Co., 1881." Very large 4°, pp. i—vi and 1-198, pl. i—xxv and one unnumbered, with twenty-five unnumbered leaves discriptive of plates.

homogeneous whole. The channel is rarely so regular as to allow the ice to be altogether free from crevasses, however. Such fissures are invariably at right angles to the line of greatest tension, and greatly facilitate melting by increasing the exposed surface; and when the rills formed by superficial melting flow into them they may be converted into cylindrical shafts, or *moulins*, extending to the base of the ice. Thus both crevasses and moulins remain practically stationary, or rather, when either has passed beyond the obstruction or irregularity of the channel which produced it, it gradually closes, and another forms in the same place, with respect to the valley and not to the moving ice, as that which it originally occupied. Aside from the longitudinal medial moraines the surface of the ice is often indistinctly marked by depressed transverse bands within which wind-blown sand or dust accumulates (known as *dirt-bands*); which bands curve downward medially more and more toward the debouchure of the glacier, and thus attest the differential motion of the various parts of the ice-stream. There are, moreover, occasional scattered blocks of stone and small pebbles lying upon the surface of the ice. The larger blocks prevent superficial melting of the ice on which they rest, and hence become apparently lifted on columns of ice, forming *glacier-tables*, which sometimes reach a height of some feet; while the smaller pebbles, on the other hand, facilitate melting, and thus gradually sink into miniature wells perhaps several inches in depth.

Glaciers of the alpine type are supplied by the perpetual snows accumulating in the elevated valleys and plains intervening between the highest peaks. Over these snowfields—the *névé* or *firn*—the snow is generally granular and contains much air, especially near the surface; though where it is thick its basal portions may approximate true ice in structure. It is only when the névé passes over the considerable declivity generally separating the snow-field from the ice-stream proper, and descends below the snow-line, however, that it becomes compacted, deprived of its air, and diminished in volume, so as to constitute a veritable glacier. A glacial area may accordingly be divided into two distinct regions on this basis alone;—the névé, the locality of no melting but of constant addition; and the glacier proper, the locality of constant decrease. In polar regions the glacial phenomena are more varied. Thus, in Greenland, the transition may be observed from glaciers of the characteristic alpine type to those of the characteristic polar type, in which the snow-line is at the sea level and the ice is essentially identical with the Swiss névé, though of vastly greater thickness. It is only slow-moving glaciers of the polar type that give origin to ice-bergs—the terminal portion extending into the sea "until the buoyancy of the ice causes a mass to break away from its attachments, rise to the surface, and float away, (p. 28,) scattering the debris frozen to its base over the sea-bottom as it gradually melts; for the bergs, as the névé of which they are formed, are generally destitute of superficial accumulations of earth and stones.

Since in the circumpolar regions the snow-line descends to the sea-level, the ice of winter may not be melted during the succeeding summer, but may remain *in situ* for years or ages, as in the paleocrystic sea seen by Nares. Now such a sea might be itself overspread with snow to such a depth as to depress the ice to the sea-bottom and to convert the whole mass into névé similar to that of northern Greenland, or into a true continental glacier. Indeed,—"it seems probable that the so-called antoretic continent is nothing but an immense sheet of ice such as this paleocrystic sea would become if it were to increase in depth until it fastened on the bottom of the sea." (p. 31.)

III. *Distribution of the existing glacier.*—In the Scandinavian mountains there are the large snow-field in the gostedal highland with many scattered glaciers of considerable interest, and, in lat. 70°, a vast snow-field with an immense ice-stream descending to the sea level; while on the opposite side of Russia the Ural range is without glaciers. In the Pyrenees the glaciers are much shrunken, and mainly confined to moist northern slopes, though about one hundred in number. In the Alps there are over a thousand glaciers, occupying, with the névé, about one-seventh of the mountainous alpine region. Eastward there are no glaciers until the Caucasus is reached, where a considerable snowy range, with ice-streams on both slopes, is found. A few scattered glaciers are known in Asia Minor, one in Persia (on the volcano Demarend,) and many on Hindu Kush; though these have been but imperfectly described. In the Himalayas the glaciers are of remarkable size and extent, though as yet but partially known. In the Southern Alps of New Zealand the glaciers are also of considerable extent and of great interest. On the western hemisphere glaciers occur along the western border of South America as far north as Upper Chili, where they mainly disappear, and are but meagerly represented along the Andes and Cordilleras until Oregon and Washington Territory are reached. Those occurring within the United States are of little prominence, however; but they increase in size and number northward, until at Mount St. Elias the ice reaches the sea level. In both Arctic and Antarctic regions there are also immense bodies of moving ice or névé, constituting glaciers of the polar type.

It thus appears that glaciers are mainly confined (*a*) to regions of great cold and considerable precipitation, (*b*) to mountain ranges along western coasts outside of the trade-wind zones in regions of heavy and frequent precipitation, and (*c*) to interior ranges of great height and considerable snow-fall; while (*a*) broad arid areas—even though "the ground is frozen to the depth of several hundred feet" (p. 36),—(*b*) interior ranges of limited snow-fall, and (*c*) regions having a hot and dry summer, are generally free from glaciers. The essential conditions for glaciation are hence, 1st., cold of considerable intensity; 2nd., considerable snow-fall; and 3rd., the absence of a dry season of sufficient length to melt the winters' snow.

IV. *Distribution of ancient glaciers.*—"The most remarkable fact that has been discovered by geologists during this century is, that at various times in the earth's history the glaciers, which now cover but a very small space on the earth's surface, certainly not over about one hundreth of its area of land, have been extended until they occupied a very large part of land and sea "(p. 38)." The glacial records are, however, so ephemeral that none save the last ice-period can ever be well known to us. During this period the accumulation of ice was most extensive in regions where glaciers yet prevail, or where the various meteorological conditions at least approach those which existing ice-fields indicate to be essential for glaciation, as in the Alps, the Pyrenees, and Scandinavia, over northern Europe, and in the Himalayas and New Zealand, on the eastern hemisphere; and over much of the northern portion of North America and a lesser area in the southern extremity of South America as well as isolated localities along the Andes and Cordilleras, in the western hemisphere. Over the plains of Switzerland an ice-sheet more than 4,000 feet thick swept its debris to the flanks of the Jura, a hundred miles away; but on the northern slope of the Alps the extension was less. Here the direction of motion was everywhere determined or at least modified by local topographical features. In the Pyrenees, the Appenines, the volcanic mountains of central France, and the Jura, in the Vosges, and in Corsica, the accumulation of ice was little more than the development of an extensive system of local glaciers; and north of the Alps there is little evidence of glaciation within inland Europe. The most complete testimony concerning European glaciation in the Quaternary, is furnished by Scandinavia and Great Britain. "Stretching from Scandinavia across the North

Sea, which it must have nearly closed, the North Europe glaciers extended over Scotland, all the north of England, and probably all of Ireland. On the north its limits were perhaps the polar ice itself, and in the west the deeper waters of the Atlantic. The southern limit of this ice-sheet was in the south-central part of England" (p. 40). This was probably "the southern edge of the polar ice tops [ice cap?] rather than a local system of glacial sheets" (p. 40). In North America the accumulation of ice was stiil more extensive, and of somewhat different character; "here the ice lay as a continuous mass, stretching down from the polar regions to the central parts of the continent, overlapping the shores for a great distance to the south along the Atlantic and Pacific coasts, and giving a continuous though irregular ice front across the land from sea to sea" (p. 41). The terminus of this sheet is yet marked by moraines as constituting the Banks of Newfoundland, George's Banks, Cape Cod, Martha's Vineyard, and Block and Long Islands, and extending thence across central New Jersey, and south as far as Washington. The attenuated margin left less distinct traces of its existence in the hills of southern Virginia, and thence into the higher Appalachians in North Carolina, whence it returned hugging the western mountain slope, and extending through West Virginia, crossing the Ohio river near the mouth of the Kanawha. Thence the southern edge of the ice skirted the north shore of the Ohio to Cincinnati, near which place it sent a lobe across the river a few miles into Kentucky. "West of Cincinnati the front of the ice sheet inclined rapidly to the north-west, and becomes hard to trace. It probably passed somewhat south of Chicago, through Iowa, and thence through Minnesota, following near the line of the Missouri to the Rocky Mountains" (p, 42). In the Cordilleras the ice was mainly confined to the higher mountains, and probably partook of the character of local or alpine glaciers within the limits of the United States; while north of our domain "we know little of its distribution" (p. 42). "There can be little doubt that the ice sheet was continuous from its southern face to the poles during the depths of the last ice time. *** This glaciated region of North America includes more than half the continent; in fact over two thirds of its surface felt the weight of the ice during the last geological period, and works its work in the existing geography" (p. 44). The thickness of the ice is not definitely known except in the vicinity of Mt. Washington, where it exceeded a mile. In South America it is probable that continental ice never extended north of the Rio de la Plata over the plains, nor beyond the Chilian coast on the Andes.

V. *The work of the glacial time.*—Water, whether liquid or solid, is a most efficient agent of erosion; but the mode of action of the two forms is quite different. Liquid water itself operates in a two-fold manner: 1st, as a chemical agent, penetrating the earth and disorganizing its constituents, forming caverns, mineral veins, and residuary products; and 2nd, as a mechanical agent, loosening, removing, and comminuting the rocky particles, and finally bearing them to the sea to form new lands; but in the solid form only mechanical activity is manifested. There is, first, the enormous weight of the glacier (more than a ton per square inch beneath a glacier a mile in thickness), enough in itself to comminute rocks not strongly coherent and well supported laterally; there is then the abrading action of this tremendous weight dragged slowly forward—the ice being armed with fragments of rock frozen into its mass; and there is finally the corroding action of the sub-glacial streams (sometimes, perhaps, under great hydrostatic pressure) which constantly bear away the finer detritus and prevent the clogging of the grinding faces of the glacial mill. The rapidity of operation of these forces must be almost beyond conception. Even in the diminutive Alpine glaciers the sub-glacial streamlets are so fully charged with impalpable mud as to carry away more material in a few days than is moved by a sub-ærial stream of like size in a year. Now, since the erosive action of the ice is proportional to its thickness, and since, moreover, this action is most effectively supplemented by sub-glacial streams in valleys, it is manifest that the tendency of glaciation is to increase the depth of existing depressions, and thus intensify topographical irregularities. Accordingly, glaciated regions are characterized by deep bays and fords along the coast line, V shaped valleys intersecting mountainous areas, and elongated basin-like ponds and lakes dotting more uniform surfaces—the longer axes coinciding with the direction of ice-motion; while at the same time abrupt peaks and irregular knobs are replaced by gracefully rounded swells with trains of fragments to the leeward. Since the average rate of glacial erosion is so high (it was a foot in a thousand years, or more than seven times as rapid as sub-ærial erosion in New England) it would appear that important geographical changes ought to follow the visitation of an ice-sheet, not only by the carrying out of a new series of hills and dales, but by heaping up of piles of earth and stones of such magnitude as to necessitate the development of a new drainage-system; and accordingly just such geographical vicissitudes are abundantly attested in north-eastern United States and elsewhere.

The most conspicous evidence of glacial action is the mantle of *drift* occupying areas formerly overspread by ice. This drift consists of the materials torn up and indiscriminately intermingled by the glacier, and is generally a confused, unstratified mass of stones of all sizes and shapes, generally much worn, cemented together by sand and clay. It is sometimes heaped up in irregular moraines; some of which doubtless mark the lines of greatest extension of the ice, while others probably indicate temporary pauses or re-advances in its secular retreat. Along the coast this deposit has been re-arranged superficially by wave and tide, and has afforded material for immense accumulations of *terrace drift*; the unmodified basal portion being sometimes left in the form of gracefully arched *lenticular hills* of elliptical outline, the longer axis extending in the direction of motion of the ice. In regions not submerged at the close of the ice-period the upper portion of the drift has been modified by the action of running water and of vegetal growth. The moving water was rendered effective during the retreat of the ice, not so much by the increased volume to be borne sea-ward as by the imperfection of the nascent drainage system. The valleys were clogged with glacial waste, forming hosts of pools and lakelets which burst from time to time and shifted the hetrogeneous mass here and there in a series of pygmy debacles. The terraces of this period along the Connecticut river and its tributaries contain scores of cubic miles of drift thus re-arranged, and indicate by their altitude that much more material than that now remaining has been removed. Among the minor drift phenomena are the isolated hills and greatly elongated ridges of sand, gravel, or stratified clay, denominated *aasar*, *kames*, or *eskers*. "No sufficient explanation has yet been given of their origin" (p. 66). In the best instance known the deposit is probably a central terminal moraine, deposited in a valley of uniform slope, by a retreating local glacier. Other examples, however, appear to be not morainal; and it may be long before we understand the method of their formation" (p. 68).

VI. *The origin and nature of glacial periods.*—The earliest of the several hypotheses which have been put forth to explain the cause of the glacial period referred the phenomenon to the secular refrigeration of the globe; but the hypothesis is untenable, since it does not contemplate the several successive transitions from warmth to cold. A second hypothesis is that of Poisson, who suggested that in the proper motion of the solar system it might from time to time come into such proximity to, or recede to such a distance from, neighboring stellar bodies

as to materially affect the temperature of the planets. "This seemed a very reasonable view, and, indeed, it cannot well be questioned that if one-half of the heat that reaches the earth's surface comes from the stars, it is likely to be warmer near an aggregation of three suns than it is where we are now" (p. 70); but astronomical considerations show that the hypothesis as a whole is untenable. Next is the view of Lyell, who attributed climatal oscillations to changes to the relative position of sea and land; but the view is open to the sweeping objection that the formulated cause would produce opposite effects from those which the hypothesis attempts to explain. The effect of minor geographical alterations on climate cannot, however be denied. Tyndall and others have shown that slight variations in the quantity of aqueous vapor, carbonic acid, or some other substances contained in the atmosphere must materially effect terrestrial temperature; but any such variations which we are justified in assuming would probably be inadequate to alone explain the phenomena of the glacial period. The next hypothesis is that of Croll, who, recognizing the fact that the "orbit of the earth around the sun is not circular, as it might be if the earth were the only companion of the sun in the solar system" (p. 73), points out (1) that during periods of high eccentricity in the terrestrial orbit the precession of the equinoxes may lead to a considerable variation in the length of the seasons, and hence to an accumulation of snow and ice in the hemisphere having the long winter and the short summer; and (2) that when such accumulation was in the northern hemisphere the effect upon the trade winds would be such as to deflect the Gulf Stream feeders to the south of Cape St. Roque and thence into the Antarctic regions, and thus further refrigerate the northern hemisphere. The hypothesis is the most important yet enunciated, though it presents certain difficulties. Other views are that changes in the earth's axis of rotation, or in the obliquity of the ecliptic may materially affect the temperature of the globe; but these views can be mathematically proven to be inadequate. Yet another hypothesis is that which attributes the phenomenon to variations in solar emission, and which "seems a most likely cause of glacial conditions" (p. 90). Less important hypothetical causes are minor geographical changes affecting aërial or marine currents—for instance, the comparatively recent elevation of Sahara, and the probable late Quaternary depression and subsequent re-elevation of Alaska and Kamchatka; but it is clear that no conceivable array of geographical changes can explain the origin of the last glacial epoch.

(To be continued.)

THE HIPPOPOTAMUS.—Dr. Henry C. Chapman, of Philadelphia, has recently devoted much attention to the anatomy of the Hippopotamus, and has read an elaborate paper before the Academy of Natural Sciences, of Philadelphia. We notice that he draws the following conclusions: "beginning with the pig, we pass by an easy transition to the Piccary, which leads to the Hippopotamus, and thence in diversing lines to the Ruminantia on the one hand and the Manatee on the other. Paleontologists have not discovered a form which bridges over the gap between the Hippopotamus and the Manatee, but it will be remembered that certain fossil bones, considered by Cuvier to have belonged to an extinct species of Hippopotamus, *H. Medius*, are regarded by Gervais as the remains of the *Halithorerium fossile*, an extinct Sirenean of which order the Manatee is a living representative." Dr. Chapman adds further on, "I do not mean to imply that the Manatee has necessarily descended from the Hippopotamus," but he considers that "there is some generic connection between them."

PROF. C. V. RILEY believes that the diminished virulency of Phylloxera in sandy soils is due to its mechanical action on the insect, his own experiments showing the difficulty such insects meet with in soils of a sandy nature.

NEW YORK ACADEMY OF SCIENCES.

November 21, 1881.

SECTION OF BIOLOGY.

The President, DR. J. S. NEWBERRY, in the Chair.

Thirty one persons present.

The following paper was read by Prof. LOUIS ELSBERG, M. D.

ON THE CELL-DOCTRINE AND THE BIOPLASSON-DOCTRINE.

Mr. President and Fellows of the Academy, Ladies and Gentlemen.—Last May, at the meeting of the American Laryngological Association, I rendered account of some histological investigations of the cartilages of the larynx, a report of which is published in the October Number of the *Archives of Laryngology*. As the structure of hyaline cartilage has an important bearing on my subject of this evening, I crave your attention for a few minutes for a brief review of those investigations.

You know the larynx or voice-box consists of a framework of cartilage or gristle. This cartilage is called hyaline or glasslike, because it is opalescent and looks like milk-glass. Having frequently been examined under the microscope, it has always been looked upon as one of the simplest tissues, namely, as being composed of a hard matrix or basis-substance, in which are imbedded a number of small softer bodies. These softer bodies, the cartilage corpuscles, have since the establishment of the cell-doctrine been called cartilage cells. As these cells were known to be alive, the question which scientific men have had to try to answer was: how can they obtain nutrition, being isolated and enclosed in the firm, unyielding cartilage basis-substance?

Without going too much into details, I may say that it was assumed that nourishing liquid reaches the corpuscle either by imbibition and diffusion or else through canals or fissures in the homogeneous basis-substance. The idea of the existence of "juice-channels" originates with VON RECKLINGHAUSEN, although others before him had spoken of "pores" through which nutrient juices might pass. BUDGE and others believe in the presence of regular canals for this purpose, while TILLMANNS and many with him believe that hyaline basis-substance consists of fine fibrils so closely held together by a cement-substance that the mass appears to be homogeneous; it is supposed by some that this inter-fibrillar cement-substance is a viscous, soft material which permits the imbibition of nutrient liquid; by some that there are clefts or fissures, and by others that there are regular channels tunnelled in this cement-substance. On the other hand, HEITZMANN, SPINA, FLESCH and others have found that there are cilia-like offshoots or prolongations of the substance of the corpuscle penetrating into the basis-substance. Such prolongations might carry on nutrition. I have had the opportunity 6 or 7 years ago to repeat Heitzmann's observations under his own eyes and with his assistance; but the results as to their correctness at which I arrived, were to the best of my belief uninfluenced by him.

My own recent investigations have not only confirmed the existence of such offshoots and shown that they form an inter-connected reticulum or network throughout the basis-substance, but I have discovered in several specimens, small lumps in this network which, by all the tests applied to them, were proved to be lumps of living matter in various stages of existence! These investigations are illustrated by the accompanying drawings viz.

Fig. 1. exhibits the appearance of a longitudinal section of the plate of the thyroid cartilage with an amplification of 100 diam.

Fig. 2. shows offshoots from the cartilage corpuscles and the network in the basis-substance with more or less large granules interwoven, as it were, in the network.